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There is Little Association between Prehospital Delay, Persistent Symptoms, and Post-Discharge Healthcare Utilization in Patients Evaluated for Acute Coronary Syndrome

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Abstract

Aims.—Test for an association between prehospital delay for symptoms suggestive of acute coronary syndrome (ACS), persistent symptoms, and healthcare utilization (HCU) 30-days and 6-months post hospital discharge.

Background.—Delayed treatment for ACS increases patient morbidity and mortality. Prehospital delay is the largest factor in delayed treatment for ACS.

Methods.—Secondary analysis of data collected from a multi-center prospective study. Included were 722 patients presenting to the Emergency Department (ED) with symptoms that triggered a cardiac evaluation. Symptoms and HCU were measured using the 13-item ACS Symptom Checklist and the Froelicher's Health Services Utilization Questionnaire-Revised instrument. Logistic regression models were used to examine hypothesized associations.

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All authors contributed to the data analyses, interpretation, and writing of the manuscript. Study conception, design, material preparation, data collection and analysis were performed by Holli DeVon, Anne G. Rosenfeld, Mohamud Daya, Elizabeth Knight and Mary Lynn Brecht. The first draft of the manuscript was written by Holli DeVon and all authors commented on previous versions of the manuscript. All authors read and approved the final manuscript.

Competing Interest: none

Results.—For patients with ACS (n = 325), longer prehospital delay was associated with fewer MD/NP visits (OR, 0.986) at 30 days. Longer prehospital delay was associated with higher odds of calling 911 for any reason (OR, 1.015), and calling 911 for chest related symptoms (OR, 1.016) 6 months following discharge. For non-ACS patients (n = 397), longer prehospital delay was associated with higher odds of experiencing chest pressure (OR, 1.009) and chest discomfort (OR, 1.008) at 30 days. At 6 months, longer prehospital delay was associated with higher odds of upper back pain (OR, 1.013), palpitations (OR 1.014), indigestion (OR, 1.010), and calls to the MD/NP for chest symptoms (OR, 1.014).

Conclusions.—There were few associations between prehospital delay and HCU for patients evaluated for ACS in the ED. Associations between prolonged delay and persistent symptoms may lead to increased HCU for those without ACS.

Keywords

acute coronary syndrome; prehospital delay; healthcare utilization; outcomes

Introduction

A diagnosis of acute coronary syndrome (ACS) is often linked to adverse outcomes following hospital discharge. ACS is frequently associated with impaired functional status,[1,2] repeated Emergency Department (ED) visits,[3] and frequent healthcare utilization.[4] Furthermore, delayed treatment for ACS increases patient morbidity and mortality[5] prior to or during hospitalization. Prehospital delay is the largest factor in delayed treatment for ACS[6]. While population-based studies such as GRACE[7] and the Worcester Heart Attack Study[8] found median delay times ranging from 2.2–4.6 hours, clinical studies have shown median delay times in presentation to the ED ranging from 1–24.4 hours.[9–12] In addition, mortality increases by 7.5% for each 30-minute delay in treatment.[13–16] Despite educational and media campaigns, median prehospital delay did not decrease from 2001 and 2011.[17] Data from Worcester, MA, indicate that the median time from symptom onset to hospital arrival has not improved.[18,]

Many patients face high healthcare utilization and persistent debilitating symptoms post ACS. High healthcare utilization following evaluation for ACS may include hospital readmission, ED visits, and outpatient follow-up. According to national Medicare data, the median risk standardized 30-day readmission rate for myocardial infarction (MI) was 15.8%.[19] In one study, 20% of ACS patients were re-hospitalized within the first year after ACS, while 14% visited the ED within the first 30 days.[20] In another study, nearly 25% of patients with ACS were readmitted to the hospital within two years.[21] In addition, patients with multiple comorbidities face higher readmission rates 30-days post hospital discharge compared to patients without multiple comorbidities (21.5% vs 14.5%, respectively), adding to the potential strain on both patients and the healthcare system.[22] These hospital readmissions are costly, as rehospitalization alone accounts for over 40% of total healthcare costs in ACS patients at one year following discharge for the index hospitalization.[23] Conversely, outpatient follow up is associated with lower rates of repeat MI and death.[24] In a Canadian study however, the authors found that one in four patients did not receive any physician follow-up after seeking care in the ED for chest pain.[24] Having an established relationship with a provider was the factor most strongly associated with receiving follow-up care.[24] Finally, patients with ACS have reported persistent symptoms following hospital discharge despite receiving guideline directed care.[17] Fatigue, pain, anxiety, depression, and reduced mobility heavily burden patients and impair their quality of life.[17]

Although prehospital delay remains a significant barrier in obtaining timely treatment for potential ACS, delayed treatment is associated with poorer outcomes. In addition, frequent healthcare utilization is a significant consequence of ED evaluation for ACS. Finally, most patients presenting to the ED and evaluated for ACS are undiagnosed on arrival and final diagnosed isn't established until a thorough work-up has been completed.[25] Approximately 10–20% of individuals presenting to the ED with cardiac-type symptoms are confirmed to have ACS.[25] Symptom differences also do not vary substantially between those who rule-in for ACS and those who rule-out for ACS.[26] Hence, the inclusion of both groups in the study of prehospital delay and subsequent healthcare utilization is important.

In summary, studies indicate that delayed treatment is associated with increased morbidity and mortality; prehospital delay is the largest component of delayed treatment; and healthcare utilization is related to indicators/predictors of morbidity and mortality. Thus, characterizing these relationships is valuable because it could inform clinicians in guiding patients in symptom management and when to seek timely care for symptoms. Therefore, we hypothesized that prehospital delay would be more likely to be associated with persistent symptoms and healthcare utilization at 30 days and 6 months post hospital discharge. Specific aims of this study were to determine if: 1) if there was a relationship between prehospital delay and persistent symptoms; and 2) if there was an association between prehospital delay for symptoms suggestive of ACS and subsequent healthcare utilization 30-days and 6-months post hospital discharge.

Methods

Design, Sample, and Setting

This was a secondary analysis of data from a study whose primary aim was to determine if there were sex differences in ACS symptoms. The dataset consisted of 1,064 patients presenting to one of five EDs in the Western, Southwestern, and Midwestern United States (U.S.) with symptoms that triggered a cardiac evaluation for suspected ACS. Patients (n=722) with complete data on all variables were included in this analysis. Patients were eligible to participate if they experienced symptoms that prompted them to go to the ED and received a cardiac evaluation in the ED. Patients whose condition was initially unstable and who went directly to the cardiac catheterization lab were included in the study but were enrolled following stabilization and cardiac interventions. Final diagnosis (ACS versus non-ACS) was determined by the attending physician. The cohort of patients presenting with ACS like symptoms who were ruled-out for ACS served as an important comparison group. Four hundred seventy-four patients had a confirmed diagnosis of ACS, and 590 patients had a non-ACS diagnosis. The dataset included 400 women and 664 men.

Procedure

Institutional Review Board approval was obtained from all clinical sites and the sponsoring institution for the parent study. This study was deemed exempt by the IRB of the sponsoring institution as all data were de-identified. Following informed consent, symptom data were collected in the ED in face-to-face interviews.[27] Prehospital delay time was calculated by subtracting the time of symptom onset from the time of registration in the ED. For those patients transferred from another hospital, delay time was calculated from symptom onset to arrival at the first hospital. If the patient could not recall the time of symptom onset, it was abstracted from the medical record. Time was rounded to the nearest quarter hour. Symptoms and healthcare utilization data were collected in phone calls 30-days and 6-months post discharge.

Measures

ACS Symptoms—Symptoms were measured with the ACS Symptom Checklist, a 13-item empirically derived instrument that measures the symptoms of ACS.[26] The 13 symptoms include: chest pressure, shoulder pain, sweating, palpitations, chest discomfort, upper back pain, shortness of breath, arm pain, unusual fatigue, nausea, lightheaded, chest pain, indigestion, and an option for other in that order. The ACS Symptom Checklist has demonstrated reliability and validity in prior studies.[28] Participants indicate whether the symptom is present or absent. Other symptoms can be recorded in a blank space marked "other." Each symptom is analyzed individually, and there is no summary score. Persistent symptoms were defined as any symptoms reported following hospital discharge.

Healthcare Utilization—Froelicher's Health Services Utilization Questionnaire-Revised[29] was used to measure subsequent clinic visits, calls to an MD/NP , visits to the ED, admissions to the hospital, myocardial infarction, and stroke. The instrument is a telephone survey and has demonstrated initial reliability and validity in Froelicher et al.'s follow-up survey of health care utilization[29] in women with cardiovascular disease. Study designed calendars marked with 30-day and 6-month time from enrollment were provided to all participants so they could easily record healthcare utilization information following hospital discharge and know when to expect a call from the investigators. Patients received a $10 gift card for their participation.

Data Analysis

Descriptive statistics were used to analyze sample demographic and clinical characteristics. Mann Whitney, t-test, or chi-squared tests were used as indicated in the analyses. Logistic regression was used to estimate associations between prehospital delay time and symptom variables, and healthcare utilization variables 30-days and 6-months following hospital discharge. A separate model was run with each symptom and healthcare utilization variable as dependent variables. The following covariates were included in the models: sex, age, race/ethnicity, income, insurance status, diabetes status, and final diagnosis (ACS vs. non-ACS). Models were also estimated for the ACS and non-ACS groups separately to elucidate potential symptom/delay time associations. A separate model was estimated for each symptom and healthcare utilization variable as a dependent variable with delay time as the predictor of interest. Models were adjusted for the same covariates except diagnosis. Analyses were run using R version 4.0.3.[30]

There were few missing data for demographic variables except for income. Patients with missing data on covariates or the specific symptom or healthcare utilization variable for each logistic regression model were excluded from analyses. To determine if there were differences between the patients with complete data compared to those with missing data, we conducted sensitivity analyses. At the 30-day follow-up, while those with missing income tended to be older, they did not differ from those who provided income data in either symptoms or healthcare utilization at 30-day follow-up. At 6-month follow-up, the pattern was more complex with those missing income (and thus not included in the logistic regression models) remaining older, but with some differences in utilization (more likely to have had heart-related calls to MD/NP) and symptoms (more likely to have shoulder or back pain or fatigue and less likely to have shortness of breath than those with income data).

Results

Characteristics of the Sample

Participants were 70.6% White/Caucasian, predominately male (62.3%) and ages ranged from 29–98 years (mean 60.64). Income data were missing for 68/722 (9.4%) participants. The majority of the sample reported an income below $50,000 (65.1%), with 30.7% having an income below $20,000 (Table 1). At 6-months, 32.6% of participants were lost to follow-up (n=149, 31.4% with ACS, n=193, 32.7% without ACS). No significant differences in baseline demographic and clinical characteristics were found between those in the 30-day follow-up sample and those at baseline who did not have 30-day follow-up data. However, by 6-month follow-up, some differences appeared; specifically, the total 6-month sample was slightly older, with a higher percentage of White/Caucasian participants, with higher reported income, and who were more likely to have health insurance than those who were lost to follow-up (Table 1).

Prehospital Delay and Persistent Symptoms

Frequency of persistent symptoms was examined for the entire cohort (patients evaluated for ACS in the ED) and by final diagnosis (ACS vs. non-ACS). For patients with ACS, 68.6% reported at least one symptom at 30 days and 55.6% at 6 months. For the no ACS group, 79.1% reported at least one symptom at 30 days and 72.5% at 6 months.

At 30-day follow up, the most frequently reported symptoms were shortness of breath , lightheadedness, unusual fatigue, chest discomfort, and shoulder pain. At 6-month follow up, the most frequently reported symptoms were shortness of breath, unusual fatigue, lightheadedness, chest discomfort, and shoulder pain (Table 2).

In patients with ACS, there was no association between prehospital delay time and symptoms at 30 days or 6 months following discharge. For non-ACS patients, longer prehospital delay was associated with higher odds of experiencing chest pressure (OR, 1.009; CI, 1.001–1.017; $p = 0.029$) and chest discomfort (OR, 1.008; CI, 1.000, 1.016; $p = 0.049$) 30 days following discharge (n =397). These results indicate that for each 1-hour increase in prehospital delay, we would expect the odds of experiencing chest pressure at 30 days following discharge to increase by a factor of 1.008. For non-ACS patients at 6 months, longer prehospital delay was associated with higher odds of experiencing upper back pain (OR, 1.013; CI, 1.003–1.023; p = 0.009), palpitations (OR 0.014; CI 1.003–1.024, p = 0.006), and indigestion (OR, 1.010; CI, 1.001, 1.019; p = 0.035) (n = 349). All results were adjusted for age, sex, race, income, insurance, and diabetes.

Prehospital Delay and Healthcare Utilization

For the total cohort, the most common forms of healthcare utilization at 30 days were MD/NP office visits for any reason (n=586, 81.5%), MD/NP office visits related to chest symptoms (n=387, 53.9%), and MD/NP calls (n=267, 37.2%) (Table 3). At 6 months, MD/NP office visits for any reason (n=552, 87.5%), MD/NP office visits related to chest symptoms (n=317, 50.3%), and MD/NP calls (n=248, 39.4%) remained the most common forms of healthcare utilization (Table 4).

For patients with ACS (n = 325), longer prehospital delay was associated with fewer MD/NP office visits (OR, 0.986; CI, 0.974– 0.997; p = 0.015) at 30 days. Longer prehospital delay was also associated with higher odds of calling 911 for any reason (OR, 1.015; CI, 1.001–1.030; p = 0.038) and calling 911 for chest symptoms (OR, 1.016; CI, 1.001, 1.031; p = 0.042) at 6 months. For non-ACS patients, there was no association between prehospital delay time and healthcare utilization at 30 days following discharge. Longer prehospital delay was associated with higher odds of calls to the MD/NP for chest symptoms (OR, 1.014; CI, 1.004–1.025; p = 0.006) at 6 months. All results were adjusted for age, sex, race, income, insurance, and diabetes.

Discussion

The purpose of the study was to determine if there was an association between prehospital delay for symptoms suggestive of ACS, persistent symptoms, and healthcare utilization at 30-days and 6-months following hospital discharge. Little is known about these relationships. We found that a high proportion of patients had persistent symptoms and the cause of the symptoms require further study.

Delay time is an important predictor of patient morbidity and mortality in patients with ACS,[31] thus we hypothesized that prehospital delay would be more likely to be associated with persistent symptoms at 30 days and 6 months post hospital discharge. There could be several plausible explanations for our findings that there were few associations among prehospital delay, symptoms, or healthcare utilization in ACS patients. First, patients who delayed seeking treatment frequently had mild, vague, or non-traditional symptoms of ACS (i.e. symptoms other than chest pain)[32] which led to their seeking treatment. Non-traditional symptoms can confuse patients, lead to consultations with family or acquaintances, or treating with home remedies further delaying time-dependent therapies. Second, all participants in the study received medical therapy including cardiac medications (e.g., beta-blockers, ACE inhibitors, calcium channel blockers, nitrates, anti-platelet agents) that would increase cardiac perfusion and mitigate symptoms. For example, beta-blockers reduce oxygen consumption by lowering heart rate. Anti-platelets reduce the risk of reocclusion leading to symptoms from ischemia. It is also possible that there was symptom overlap with other conditions. For instance, for patients with chest pain/pressure caused by indigestion or including gastroesophageal reflux disease (GERD), nitrates are not likely to be effective for non-ischemic pain. Medications may reduce persistent symptoms following ACS if the symptoms are related to ischemia but may have no effect if symptoms are caused by a non-cardiac condition. Finally, patients who are discharged with a diagnosis of ACS would be specifically directed to seek follow-up care and would receive guidance on how to respond to and manage ongoing symptoms or other health concerns.[31]

For non-ACS patients, longer delay was associated with persistent symptoms of chest pressure and chest discomfort at 30-days and indigestion, palpitations, and upper back pain at 6-months. There may be several plausible explanations for this. Non-ACS patients may have delayed seeking care in the ED as they tried to attribute a cause to their symptoms yet continued to suffer from these ongoing symptoms following discharge. More than eighty percent of patients evaluated in the ED for ACS will be ruled-out and may be experiencing musculoskeletal, rheumatologic, gastrointestinal, respiratory, psychosomatic, or other causes.[32–34] For example, gastroesophageal disorders, including GERD, are the most common causes of non-cardiac chest pain.[35] In patients with non-cardiac chest pain, GERD is present in 50–60% of cases.[36] In a retrospective study, one group of authors enrolled patients who presented to the ED complaining of chest pain as a primary symptom and experienced pain at least twice a year.[37] They found that frequent ED visits were less likely to have an underlying cardiac, musculoskeletal, or rheumatologic cause but were more likely to represent a psychosomatic disorder (33.9% vs. 9.9%).

We also found that longer prehospital delay in patients with ACS was associated with fewer MD/NP clinic visits at 30-days, and more general calls to the MD/NP, and calls related to chest symptoms at 6-months following discharge. The American College of Cardiology/American Heart Association (ACC/AHA) guidelines for ST-elevation myocardial infarction (STEMI) emphasizes timely follow up with the healthcare team after an ACS hospitalization.[31] In addition, outpatient appointments should be scheduled to reflect the goals set for each patient in accordance with their clinical condition and needs. The ACC/AHA guidelines recommend follow-up visits to assess symptoms, to evaluate psychological status, and to ensure appropriate medication use. Similarly, for patients with non-STEMI, ACC/AHA guidelines recommend outpatient follow-up for low-risk patients and patients who have undergone revascularization within 2 to 6 weeks, and earlier follow-up for higher-risk patients.[7] Therefore, we would expect that patients with ACS would have fewer clinic visits and more general calls to the MD/NP at 30 days post discharge and this is supported by our data.

For non-ACS patients, longer prehospital delay was associated with more calls to the NP/MD for chest symptoms at 6 months. Indigestion, palpitations, and upper back pain may have been interpreted by the participants as being of potential cardiac origin. Additionally, more calls at 6-months may be related to persistent symptoms or to underlying comorbid conditions. MD/NPs may also use patient-initiated calls as an opportunity to evaluate clinical symptoms; provide patient education; assess medication adherence, evaluate complications; make appointments; and schedule tests.[38,39] Finally, it is possible that those who delay seeking care for the index symptoms also utilize fewer clinic services. This may reflect a subset of patients who are more likely to use the ED for primary or non-emergent care.[40] Those patients may delay seeking care in the ED because they seldom utilize outpatient medical care or because they wait until symptoms become severe. Our sample included a high proportion of patients in low income groups (65% earned ≤$50,000). Low income has been associated with the lack of primary care provider[41,42] and more frequent ED visits.[43] Individuals who are economically disadvantaged should receive transitional care and be monitored closely for follow-up care following admission to the ED for evaluation of ACS.

Patients without ACS represent a significant population of patients with high healthcare utilization[44] and frequent readmissions[19,34,45] resulting in high health care and societal costs.[46] Most patients presenting to the ED, ruled-out for ACS, will be diagnosed with noncardiac chest pain. One challenge in the ED is that more than 5.5 million individuals present with chest pain but only 13% are diagnoses with ACS.[47] The question then becomes, what happens next for the 87% ruled-out for ACS? If these patients do not get follow-up care to assess the source of their symptoms, they may continue to have symptoms leading to more ED visits, 911 calls, or extensive healthcare utilization. This is one of the failures of the US healthcare system, which tends focus on acute illness and disease but avoid ongoing care to address continuing symptoms. The unique aspect of our data is that we have highlighted the challenges posed by patients ruled-out for ACS but for whom the etiology of symptoms may remain undiagnosed.

Data were also collected prior to the widespread use of high sensitivity (hs) troponins.[48] The newly published 2021 Guidelines for the Diagnosis and Management of Chest Pain[34] suggest that patients who have been ruled-out for ACS, with hs troponins, yet have frequent healthcare utilization, should undergo extensive testing to determine the cause of their symptoms. Unresolved symptoms up to 6 months following hospital discharge may also represent an unmet need for symptom relief interventions. Future studies may target this group to reduce unplanned hospital readmissions and high healthcare utilization. We recommend that healthcare providers include counseling at discharge on the need to seek urgent care for symptoms suggestive of ACS and that they call 911 if they have a history of ischemic heart disease or significant chest symptoms and shortness of breath.

Strengths

The study included a large, diverse, and heterogeneous sample enrolled at 5 sites. Patients were given calendars to mark the time to expect a follow-up call as well as a copy of the Froelicher instrument to record their healthcare utilization. Patients received three phone calls prior to being identified as lost to follow-up.

Limitations

There were several limitations to the study: the data were originally collected for another purpose; symptoms and healthcare utilization were self-reported; we do not know if follow-up visits were planned or unplanned; we do not know the outcomes of the follow-up visits; and nearly 1 in 3 patients were lost to follow-up for the 6-month HCU data. This is important since the 6-month sample was slightly older, had higher income, more likely to be insured, and with a higher percentage of White/Caucasian participants than those who were lost to follow-up.

Conclusion

A high proportion of patients presenting to the ED with symptoms suggestive of ACS have persistent symptoms for at least 6 months following hospital discharge, demonstrating the need for improved understanding of why patients who had access to high quality care emergency care have other ongoing complaints.[49,50] There were few associations between prehospital delay time, ongoing symptoms at 30-days following discharge, or subsequent healthcare utilization and those associations that were statistically significant had very small odds ratios. At 6-months, some associations began to emerge. Longer delay time was associated with greater likelihood of indigestion, palpitations, and upper back pain and with having made heart related calls to MD/NP. Evaluation of persistent symptoms in those ruled-out for ACS in the ED is warranted given their high health care utilization. More research is needed to determine if there is a link between prehospital delay and unscheduled healthcare utilization following hospital discharge in patients evaluated for ACS, particularly for those patients ruled- out for ACS. This knowledge could guide clinicians in helping patients to evaluate the quality and significance of future symptoms.

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Highlights

- Patients ruled-out for ACS continue to have symptoms leading to more emergency department visits, 911 calls, and healthcare utilization
- The unique aspect of our data is that we have highlighted the challenges posed by patients ruled-out for ACS but for whom the etiology of symptoms may remain undiagnosed
- More research is needed to determine if there is a link between prehospital delay and unscheduled healthcare utilization following hospital discharge in patients evaluated for ACS

Table 1.

Sample Characteristics at 30-day and 6-Month Follow-up by Cohort Status

Variable median (interquartile range), mean (SD) or frequency (%[1])	30-days Following Discharge			6-months Following Discharge		
	Total Cohort (n=722)[2]	ACS (n=325)	No ACS (n=397)	Total Cohort (n=633)[2]	ACS (n=284)	No ACS (n=349)
Delay time in hours median (Interquartile range)[3]	6.77 (23.33)	7.15 (23.18)	6.75 (24.87)	6.30 (22.17)	6.19 (22.41)	6.40 (22.60)
Age in years, mean (SD)[4]	60.64 (13.84)	**62.28 (11.77)**[**]	**59.3 (15.21)**[**]	**61.02 (13.86)**[*]	62.00 (11.98)	**60.22 (15.19)**[*]
Sex						
Male	450 (62.3%)	**232 (71.4%)**[**]	**218 (54.1%)**[**]	396 (62.6%)	**202 (71.1%)**[**]	**194 (55.6%)**[**]
Female	272 (37.7%)	**93 (28.6%)**[**]	**179 (45.1%)**[**]	237 (37.4%)	**82 (28.9%)**[**]	**155 (44.4%)**[**]
Race/ethnicity						
White or Caucasian	509 (70.6%)	225 (69.2%)	284 (71.7%)	471 (74.5%)	208 (73.5%)	263 (75.4%)
Black or African American	95 (13.2%)	41 (12.6%)	54 (13.6%)	68 (10.8%)	31 (11.0%)	37 (10.6%)
Hispanic	54 (7.5%)	30 (9.2%)	24 (6.1%)	38 (6.0%)	22 (7.8%)	16 (4.6%)
Other	63 (8.7%)	29 (8.9%)	34 (8.6%)	55 (8.7%)	22 (7.8%)	33 (9.5%)
Health Insurance						
Private from employer	239 (33.6%)	109 (34.4%)	130 (33.0%)	215 (34.4%)	97 (34.9%)	118 (34.0%)
Private paid by patient	65 (9.1%)	28 (8.8%)	37 (9.4%)	65 (10.4%)	30 (10.8%)	35 (10.1%)
Medicare	239 (33.1%)	103 (32.5%)	136 (34.5%)	212 (33.5%)	97 (32.0%)	118 (35.4%)
Government, or other, insurance	84 (11.8%)	33 (10.4%)	51 (12.9%)	68 (10.7%)	30 (10.8%)	38 (11.0%)
Not Insured	84 (11.8%)	44 (13.9%)	40 (10.2%)	65 (10.3%)	32 (11.5%)	33 (9.5%)
Income						
<$20,000	201 (30.7%)	69 **(24.2%)**[**]	132 **(35.8%)**[**]	173 (30.0%)	64 (22.5%)	109 (33.7%)
$20,000 - $50,000	225 (34.4%)	103 **(36.1%)**[**]	122 **(33.1%)**[**]	193 (33.5%)	86 (30.3%)	107 (33.1%)
$50,000 - $100,000	134 (20.5%)	77 **(27.0%)**[**]	57 **(15.5%)**[**]	118 (20.5%)	63 (22.2%)	55 (17.0%)
$100,000+	94 (14.4%)	36 **(12.6%)**[**]	58 **(15.7%)**[**]	92 (16.0%)	40 (14.1%)	52 (16.1%)
Diabetes	212 (29.4%)	99 (30.5%)	113 (28.5%)	184 (29.0%)	80 (28.3%)	104 (29.9%)
Mode of Arrival to ED						

Variable median (interquartile range), mean (SD) or frequency (%[1])	30-days Following Discharge			6-months Following Discharge		
	Total Cohort (n=722)[2]	ACS (n=325)	No ACS (n=397)	Total Cohort (n=633)[2]	ACS (n=284)	No ACS (n=349)
Self-Transport	383 (53.2%)	170 **(52.5%)***	213 **(53.8%)***	349 (55.1%)	151 (53.2%)	198 (56.9%)
EMS	319 (44.3%)	142 **(43.8%)***	177 **(44.7%)***	269 (42.5%)	122 (43.0%)	147 (42.2%)
Transfer from another facility	18 (2.5%)	12 **(3.7%)***	6 **(1.5%)***	14 (2.2%)	11 (3.9%)	3 (0.9%)

Notes.

ACS is acute coronary syndrome. SD is standard deviation. ED is emergency department.

[1]Percentages calculated from cases with non-missing data for specific variable

[2]n=0–11 cases in the total sample with missing data on sample characteristics. For 30-day follow-up, n=68 in the total sample had data missing for income (40 for ACS and 28 for no ACS). Missing for other variables in the total sample ranged from 0 to 21 (0–9 in ACS, 0–12 in no ACS). For 6-month, n=57 in the total sample had data missing for income (31 for ACS and 26 for no ACS). Missing for other variables in the total sample ranged from 0 to 19 (0–6 in ACS, 0–13 for no ACS)

[3]Mann-Whitney test used because of substantial non-normality

[4]t-test for comparison (other variables, unless noted, used chi square)

** p<.01

* p<.05; bold type

Table 2.

Frequencies of Symptoms and Healthcare Utilization at 30-days and 6-months Follow-up by Cohort Status

Variable Frequency (%[1])	30-days Following Discharge			6-months Following Discharge		
	Total Cohort (n=722)[2]	ACS (n=325)	No ACS (n=397)	Total Cohort (n=633)[2]	ACS (n=284)	No ACS (n=349)
Symptoms						
Arm Pain	143 (20.2%)	54 (17.3%)	89 (22.6%)	112 (18.0%)	35 **(12.6%)****	77 **(22.3%)****
Chest Discomfort	223 (31.4%)	85 **(26.9%)****	138 **(35.0%)****	150 (24.0%)	52 **(18.6%)****	98 **(28.3%)****
Chest Pain	161 (22.8%)	54 **(17.2%)****	107 **(27.2%)****	114 (18.2%)	42 (15.1%)	72 (20.8%)
Chest Pressure	171 (24.1%)	57 **(18.1%)****	114 **(28.9%)****	124 (19.8%)	42 **(15.1%)****	82 **(23.7%)****
Indigestion	150 (21.3%)	58 (18.6%)	92 (23.4%)	140 (22.5%)	35 **(12.6%)****	105 **(30.5%)****
Lightheadedness	224 (31.9%)	90 (28.7%)	134 (34.0%)	155 (24.9%)	54 **(19.4%)****	101 **(29.3%)****
Nausea	113 (16.1%)	27 **(8.6%)****	86 **(22.0%)****	104 (16.6%)	26 **(9.3%)****	78 **(22.5%)****
Palpitations	130 (18.4%)	49 (15.7%)	81 (20.6%)	109 (17.5%)	35 **(12.5%)****	74 **(21.4%)****
Shortness of Breath	252 (35.7%)	90 **(28.6%)****	162 **(41.4%)****	176 (28.2%)	59 **(21.4%)****	117 **(33.9%)****
Shoulder Pain	179 (23.3%)	62 **(19.7%)****	117 **(29.8%)****	143 (22.9%)	45 **(16.1%)****	98 **(28.4%)****
Sweating	160 (22.5%)	50 **(15.8%)****	110 **(27.9%)****	105 (16.8%)	36 **(12.9%)****	69 **(20.0%)****
Unusual Fatigue	224 (31.0%)	86 **(27.3%)****	138 **(35.0%)***	166 (26.6%)	65 (23.3%)	101 (29.2%)
Upper Back Pain	149 (21.0%)	51 **(16.2%)****	98 **(24.8%)****	119 (19.0%)	35 **(12.5%)****	84 **(24.3%)****
Healthcare Utilization [2]						
MD/NP visits-any reason	586 (81.5%)	277 **(85.8%)****	309 **(78.0%)****	552 (87.5%)	241 (85.5%)	311 (89.1%)
MD/NP visits for chest symptoms	387 (53.9%)	212 **(65.8%)****	175 **(44.2%)****	317 (50.3%)	177 **(63.0%)****	140 **(40.1%)****
MD/NP calls-any reason	267 (37.2%)	118 (38.8%)	149 (37.6%)	248 (39.4%)	95 **(33.8%)****	153 **(43.8%)****
MD/NP calls for chest symptoms	132 (18.4%)	62 (19.4%)	70 (17.7%)	121 (19.2%)	59 (21.1%)	62 (17.8%)
911 calls-any reason	47 (6.6%)	22 (6.9%)	25 (6.3%)	89 (14.1%)	35 (12.4%)	54 (15.5%)
911 calls for chest symptoms	34 (4.8%)	14 (4.4%)	20 (5.1%)	57 (9.1%)	28 (10.0%)	29 (8.3%)
ER visits-any reason	121 (16.8%)	57 (17.6%)	64 (16.2%)	197 (31.2%)	87 (30.7%)	110 (31.5%)

Variable Frequency (%[1])	30-days Following Discharge			6-months Following Discharge		
	Total Cohort (n=722)[2]	ACS (n=325)	No ACS (n=397)	Total Cohort (n=633)[2]	ACS (n=284)	No ACS (n=349)
ER visits for chest symptoms	72 (10.1%)	35 (11.0%)	37 (9.3%)	105 (16.7%)	50 (17.7%)	55 (15.8%)
Overnight hospital stay	83 (11.5%)	34 (10.5%)	49 (12.3%)	106 (16.8%)	43 (15.2%)	63 (18.1%)

Notes.

[1] Percentages calculated from 30-day sample cases with non-missing data

[2] n=2–18 cases in the total sample with missing data on symptoms and health utilization variables; similar missing data pattern for ACS and no ACS subgroups.

* $p<0.05$

** $p< 0.01$

Table 3:

Relationships among delay time with 30-day follow-up symptoms and healthcare utilization outcomes (adjusted for covariates)[1,2]

	Total Sample		ACS (n=325)		No ACS (n=397)	
	OR (95% CI)	**p**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Symptom [3]						
Arm Pain	1.001 (0.993, 1.008)	0.878	0.994 (0.980, 1.009)	0.444	1.004 (0.995, 1.012)	0.424
Chest Discomfort	1.002 (0.996, 1.009)	0.441	0.992 (0.981, 1.004)	0.216	1.008 (1.000, 1.016)	**0.049***
Chest Pain	1.003 (0.996, 1.009)	0.426	0.996 (0.982, 1.009)	0.537	1.005 (0.997, 1.013)	0.222
Chest Pressure	1.005 (0.998, 1.012)	0.137	0.993 (0.980, 1.007)	0.317	1.009 (1.001, 1.017)	**0.029***
Indigestion	1.004 (0.997, 1.011)	0.279	0.996 (0.983, 1.010)	0.572	1.007 (0.999, 1.015)	0.107
Lightheadedness	1.000 (0.993, 1.006)	0.883	0.998 (0.987, 1.010)	0.781	0.999 (0.991, 1.007)	0.856
Nausea	1.006 0.999, 1.014)	0.093	1.009 (0.994, 1.025)	0.223	1.005 (0.996, 1.014)	0.260
Palpitations	1.002 (0.995, 1.009)	0.492	1.008 (0.996, 1.020)	0.185	0.999 (0.990, 1.008)	0.823
Shortness of Breath	1.002 (0.995, 1.008)	0.576	0.998 (0.987, 1.010)	0.770	1.004 (0.996, 1.012)	0.314
Shoulder Pain	0.999 (0.992, 1.006)	0.832	0.995 (0.981, 1.008)	0.441	1.001 (0.993, 1.010)	0.743
Sweating	1.003 (0.995, 1.010)	0.477	0.997 (0.983, 1.011)	0.656	1.006 (0.997, 1.014)	0.214
Unusual Fatigue	0.998 (0.992, 1.004)	0.580	0.994 (0.982, 1.005)	0.289	1.001 (0.993, 1.008)	0.896
Upper Back Pain	1.003 (0.995, 1.009)	0.478	1.000 (0.987, 1.013)	0.993	1.003 (0.995, 1.012)	0.436
Healthcare Utilization [4]						
MD/NP visits	0.994 (0.987, 1.001)	0.087	0.986 (0.974, 0.997)	**0.015***	0.998 (0.989, 1.007)	0.713
Visits for heart symptoms	0.998 (0.992, 1.004)	0.505	0.990 (0.981, 1.000)	0.055	1.002 (0.995, 1.010)	0.513
MD/NP calls	1.003 (0.997, 1.009)	0.345	1.004 (0.994, 1.014)	0.427	1.002 (0.994, 1.010)	0.604
Calls for heart symptoms	1.002 (0.997, 1.009)	0.622	1.007 (0.996, 1.018)	0.235	0.999 (0.989, 1.009)	0.835
911 calls-any reason	0.993 (0.978, 1.005)	0.314	0.996 (0.976, 1.018)	0.743	0.990 (0.972, 1.009)	0.302
911 calls for heart symptoms	0.999 (0.969, 1.005)	0.219	0.978 (0.940, 1.017)	0.268	0.993 (0.973, 1.013)	0.480
ER visits	0.999 (0.971, 1.007)	0.822	1.001 (0.989, 1.013)	0.915	0.998 (0.988, 1.009)	0.769

	Total Sample		ACS (n=325)		No ACS (n=397)	
	OR (95% CI)	**p**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
ER visits for heart symptoms	0.999 (0.988, 1.008)	0.790	1.001 (0.985, 1.017)	0.921	0.999 (0.985, 1.013)	0.839
Overnight hospital stay	1.000 (0.991, 1.009)	0.978	1.009 (0.996, 1.022)	0.186	0.994 (0.981, 1.006)	0.335

Notes.

[1] Analysis sample sizes: n=266–276 for ACS; n=359–365 for no ACS; n=625–641 for total sample (sample sizes differ across models because of missing data)

[2] Covariates: ACS status (reference category: no), age, gender (ref: male), race (ref: white), income (ref: <$20,000), insurance (ref: no insurance), diabetes (ref :no)

[3] Reference category for symptom outcomes is "symptom not reported [severity=0]"

[4] Reference category for utilization outcomes is zero visits, zero calls, no overnight stay

[*] p<.05, bold type

Table 4:

Relationships among delay time with 6-month follow-up symptoms and healthcare utilization outcomes (results from logistic regression with covariates)[1,2]

	Total Sample		ACS		No ACS	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Symptom						
Arm Pain	1.000 (0.991,1.009)	0.939	0.993 (0.976,1.010)	0.420	1.004 (0.993, 1.014)	0.503
Chest Discomfort	1.006 (0.998, 1.013)	0.146	1.004 (0.992, 1.017)	0.504	1.007 (0.997, 1.016)	0.175
Chest Pain	1.005 (0.997, 1.013)	0.236	1.001 (0.986, 1.015)	0.944	1.008 (0.998, 1.019)	0.122
Chest Pressure	1.001 (0.991, 1.008)	0.912	0.992 (0.977, 1.008)	0.344	1.003 (0.993, 1.013)	0.572
Indigestion	1.008 (1.000, 1.015)	0.044*	1.005 (0.990, 1.020)	0.537	1.010 (1.001, 1.019)	**0.035***
Lightheadedness	1.002 (0.995, 1.009)	0.554	0.994 (0.980, 1.008)	0.383	1.005 (0.996, 1.015)	0.249
Nausea	1.007 (0.999, 1.016)	0.079	1.014 (0.999, 1.029)	0.076	1.006 (0.995, 1.016)	0.277
Palpitations	1.011 (1.003, 1.019)	**0.006***	1.006 (0.993, 1.020)	0.377	1.014 (1.003, 1.024)	**0.009***
Shortness of Breath	1.000 (0.993, 1.008)	0.924	0.995 (0.981, 1.008)	0.439	1.004 (0.994, 1.013)	0.453
Shoulder Pain	0.999 (0.990, 1.007)	0.784	0.994 (0.979, 1.010)	0.490	1.000 (0.991, 1.010)	0.932
Sweating	1.002 (0.993, 1.010)	0.688	1.000 (0.984, 1.015)	0.959	1.002 (0.991, 1.013)	0.738
Unusual Fatigue	1.003 (0.996, 1.011)	0.353	1.003 (0.991, 1.015)	0.660	1.005 (0.995, 1.014)	0.334
Upper Back Pain	1.008 (1.000, 1.015)	0.054	0.998 (0.983, 1.014)	0.802	1.013 (1.003, 1.023)	**0.009***
Healthcare Utilization						
MD/NP visits-any reason	1.009 (0.998, 1.021)	0.141	1.006 (0.990, 1.022)	0.463	1.014 (0.996, 1.033)	0.122
Visits for chest symptoms	1.005 (0.998, 1.011)	0.170	1.010 (0.998, 1.021)	0.112	1.003 (0.994, 1.011)	0.559
MD/NP calls-any reason	1.004 (0.997, 1.010)	0.281	1.007 (0.996, 1.018)	0.196	1.003 (0.994, 1.012)	0.492
Calls for heart symptoms	1.011 (1.003, 1.018)	**0.006***	1.008 (0.997, 1.020)	0.161	1.014 (1.004, 1.025)	**0.006***
911 calls-any reason	1.001 (0.992, 1.011)	0.759	1.015 (1.001, 1.030)	**0.038***	0.993 (0.980, 1.007)	0.335
911calls for chest symptoms	1.006 (0.995, 1.016)	0.236	1.016 (1.001, 1.031)	**0.042***	1.000 (0.984, 1.016)	0.990
ER visits-any reason	0.996 (0.988, 1.003)	0.252	0.997 (0.986, 1.009)	0.646	0.994 (0.984, 1.004)	0.255
ER visits for chest symptoms	0.998 (0.989, 1.007)	0.674	0.998 (0.984, 1.012)	0.769	0.998 (0.986, 1.011)	0.796

	Total Sample		ACS		No ACS	
	OR (95% CI)	**p**	**OR (95% CI)**	**p**	**OR (95% CI)**	**p**
Overnight hospital stay	1.001 (0.992, 1.009)	0.827	0.991 (0.974, 1.008)	0.294	1.007 (0.996, 1.018)	0.213

Notes.

[1] Analysis sample sizes: n=240–245 for ACS; n=316–320 for no ACS; n=556–565 for total sample (sample sizes differ across models because of missing data)

[2] Covariates: ACS status (reference category: no), age, gender (ref: male), race (ref: white), income (reference: <$20,000), insurance (reference: no insurance), diabetes (reference: no diabetes)

[*] $p<0.05$